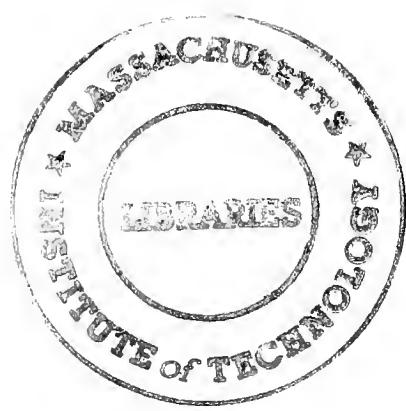


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IS THE GASOLINE TAX REGRESSIVE?

James M. Poterba

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## ABSTRACT

Claims of the regressivity of gasoline taxes typically rely on annual surveys of consumer income and expenditures which show that gasoline expenditures are a larger fraction of income for very low income households than for middle or high-income households. This paper argues that annual expenditure provides a more reliable indicator of household well-being than annual income. It uses data from the Consumer Expenditure Survey to re-assess the claim that gasoline taxes are regressive by computing the share of total expenditures which high-spending and low-spending households devote to retail gasoline purchases. This alternative approach shows that low-expenditure households devote a smaller share of their budget to gasoline than do their counterparts in the middle of the expenditure distribution. Although households in the top five percent of the total spending distribution spend less on gasoline than those who are less well-off, the share of expenditure devoted to gasoline is much more stable across the population than the ratio of gasoline outlays to current income. The gasoline tax thus appears far less regressive than conventional analyses suggest.

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The long-standing view that excise taxes such as the gasoline tax are regressive, imposing a heavier burden on low-income households than on their higher-income counterparts, played a central role in shaping the 1990 budget compromise. This issue is certain to be debated again, since these taxes are frequently considered as a means to achieve environmental, budgetary, and national security objectives (see Congressional Budget Office (1986)). Claims of the regressivity of excise taxes typically rely on annual surveys of consumer income and expenditures which show that gasoline expenditures are a larger fraction of income for very low income households than for middle or high-income households (see for example KPMG Peat Marwick (1990)). Several recent studies, however, notably Kasten and Sammartino (1988) and Poterba (1989), suggest that year-to-year fluctuations in income among households at the bottom of the annual income distribution may exaggerate the regressivity of excise taxes. From a life-cycle perspective, these taxes, particularly the gasoline tax, are much less regressive than is commonly believed.

This paper argues that annual expenditure provides a more reliable indicator of household well-being than annual income. Whether a given tax is regressive should therefore be analyzed by testing whether it places higher burden on low-expenditure households than on their high-expenditure counterparts. My empirical analysis uses data from the Consumer Expenditure Survey to compute the share of total expenditures which high-spending and low-spending households devote to retail gasoline purchases. This alternative approach to measuring the distributional burden of gasoline taxes yields results which are strikingly different from those using the traditional approach based on annual income.

Low-expenditure households devote a smaller share of their budget to gasoline than do their counterparts in the middle of the expenditure distribution. Although households in the top five percent of the total spending distribution spend significantly less on gasoline (as a share of expenditures) than those who are less well-off, gasoline's expenditure share is much more stable across the population than the ratio of gasoline outlays to current income. The reduced estimate of gasoline tax regressivity is not an inherent feature of using expenditures rather than income as a basis for assessing incidence. Some other energy expenditures, such as electricity, exhibit different cross-sectional patterns with much higher expenditure shares for low rather than high income households.

This study underscores a conclusion of the recent Congressional Budget Office (1990) excise tax study: "measured as a percentage of total expenditures, ... outlays on these goods [subject to excise taxes] tend to be more equal [than outlays as a share of income] across family income classes.(p.xviii)." However, this paper moves beyond the CBO study, which focuses on gasoline's share of total outlays for households in different income categories. If lifetime income is better proxied by total expenditures than by current income, a more complete procedure involves ranking households by expenditures rather than income, and considering the resulting distribution of budget shares.

This paper is divided into five sections. The first presents summary statistics on the patterns of gasoline expenditure as a share of income and total expenditure, motivating subsequent analysis of what explains the differences between these incidence measures. It also considers the variation in expenditure patterns within income or expenditure categories, to provide

some evidence on the horizontal equity of gasoline tax changes. This study focuses exclusively on household gasoline consumption, assuming that neither diesel fuel nor intermediate uses of gasoline are taxed.

Section two explores the characteristics of households who fare relatively better in the expenditure than in the income distribution. Nearly forty percent of these households are either elderly or very young, suggesting that divergence between income and outlays may reflect long-term economic planning. Another significant group is experiencing economic hardship, such as unemployment or disability; in some cases these circumstances may be short term.

Section three examines the role of indexed transfer payments in offsetting tax-induced increases in gasoline prices for some households, particularly those near the bottom of the income and expenditure distributions. Low-income and low-expenditure households are much more likely to receive indexed transfers than are better-off households; nearly two thirds of the income received by households in the lowest expenditure decile is indexed. These programs blunt the regressivity of excise taxes by automatically increasing household receipts in response to consumer price increases.

Section four considers the efficiency cost of the gasoline tax in light of other government policies such as Corporate Average Fuel Economy (CAFE) standards which affect the complexion of the U.S. auto fleet. If the CAFE standards bind both before and after a gasoline tax increase, the efficiency cost of such a change is significantly smaller than estimates which ignore this constraint would suggest. Finally, a brief conclusion suggests several extensions of this work, both for analyzing the burden of motor fuel taxes and for examining excise taxes more generally.

### 1. Who Buys Gasoline? Income vs. Expenditure Incidence Results

The annual income distribution is unstable from year to year. In the Panel Survey of Income Dynamics, for example, a randomly chosen individual had only a 41% chance of being in the same income quintile in 1971 and 1978.<sup>1</sup> There was somewhat less mobility out of the bottom quintile, where 54% remained in both surveys, than other quintiles. Since households move across income categories, categorizing them as well-to-do or poor based on annual income data provides a noisy measure of long-term economic status.<sup>2</sup> Even modest mobility is sufficient to alter basic results on the distributional burden of taxes, particularly excise taxes. In Canadian data, Davies, St. Hilaire, and Whalley (1984) find that the average burden of sales and excise taxes for the lowest income decile, while 27% of annual income, is only 15% of lifetime income.<sup>3</sup> In their study, the average burden of excise taxes across all income groups is 13%, so the lifetime income calculation suggests much less excise tax regressivity than annual income data. For the highest income decile, the burden of excise taxes rises from 8.5% of annual income to 12.4% of lifetime income.

Focusing on lifetime income introduces two considerations which are absent in incidence computations based on annual income. First, there are

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<sup>1</sup>Poterba (1989) reports further details on income mobility in the PSID, as well as other data sets which permit some analysis of income fluctuations.

<sup>2</sup>Some earlier incidence studies [for example, Pechman (1985)] exclude very low income households precisely because their annual income may be a noisy measure of permanent income.

<sup>3</sup>Lifetime income is the present discounted value of a household's income throughout the lifetime. It is difficult to measure ex ante, but can be estimated using data on the stochastic properties of household income from year to year.

predictable life-cycle patterns in earnings, asset accumulation, and consumption. Elderly households, for example, may spend more than their current income by drawing down assets. Their low annual income may provide a poor indicator of their economic status. Second, lifetime income is effectively a multi-year average of annual income. It is less sensitive to variation in a given year's earnings due to unemployment, changes in family status, or other transitory circumstances.

The notion that households behave on the basis of long-term income underlies the life-cycle and permanent-income theories of consumption. These theories, which are the foundation for most modern analyses of household consumption behavior, imply that a household's total expenditures may be a more reliable indicator of economic well-being than the same household's annual income.<sup>4</sup> This insight provides the theoretical rationale for the empirical analysis which follows. Even if consumption is not set precisely in accordance with the permanent income hypothesis, for most households it is likely to reflect at least some forward- and backward-looking behavior, therefore offsetting some of the transitory noise in annual income.<sup>5</sup>

Similar arguments play an important part in the ongoing debate on whether income or consumption is a more appropriate tax base. If consumption is a

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<sup>4</sup>A recent study by Carroll and Summers (1989) shows that within cohorts, occupations, and other broad groups, average consumption tracks average income over the lifecycle. This casts doubt on the broad proposition that households save for retirement, but does not imply that for a given household, current income and current consumption move in tandem.

<sup>5</sup>The KPMG Peat Marwick (1990) study of excise tax regressivity acknowledges the potential limitations of basing regressivity calculations on annual income data, but argues that solving this problem requires many years of income data to compute permanent income. However, total consumption can provide information on long-run income even in a single cross section.

better measure of a household's taxable capacity than its current income, then studies of the tax burden — regardless of whether that burden is comprised of income or consumption taxes — should use a measure of consumption to estimate a household's ability to pay. At a minimum, consumption outlays provide an interesting alternative perspective on the distribution of the tax burden across households.

### 1.1 Data and Sample

Data on income and expenditure patterns are drawn from the 1985 Consumer Expenditure Survey, a stratified national sample of approximately two thousand households. Households are interviewed four times during their CES experience, and at any moment, nearly five thousand households are taking part in the Consumer Expenditure Survey. My data sample includes only 1582 households — all those whose first expenditure interview occurred during the first or second quarter of 1985 (a total of 2608 households), who reported four consecutive quarterly expenditure interviews (a subsample of 1889 households), and with complete data on household income (a subset of 1582 households).<sup>6</sup>

Household income is defined as the average of pre-tax income reported in the first and last quarterly interview. In each of these interviews, households are asked about their income over the previous twelve months. This income measure, while a standard basis for assessing household economic status, is imperfect for two reasons. First, while it includes cash transfer

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<sup>6</sup>Households with incomplete income data failed to respond completely to income questions in at least one interview. This nonresponse pattern may be correlated with household economic status, and might bias the distributional estimates in later sections.

payments such as Social Security or welfare, it excludes in-kind transfers such as Food Stamps or Medicaid. Valuing such transfers is difficult, but assuming a value of zero systematically understates the income of some poverty households. Second, the income measure does not reflect tax payments. This is due to data difficulties: the incomplete reporting of tax payments and the asynchronous nature of the tax data (last calendar year) and income data (current calendar year) in the Consumer Expenditure Survey.<sup>7</sup>

Total expenditures are the sum of total expenditures in each of the four interview quarters, excluding any outlays for new or used automobiles. The expenditure total includes the CES estimate of the rental equivalent value of owner-occupied housing services for homeowners, as well as rental outlays for households who do not own homes.<sup>8</sup> Auto purchases are excluded to avoid spurious volatility in the expenditures measure, since this purchase can be a large fraction of all other outlays in a given year. The robustness of the findings to this assumption is explored in later sections.

Using both income and expenditure measures, households are assigned to deciles of the income or spending distribution.<sup>9</sup> Summary statistics, principally averages of expenditure shares or expenditure-to-income ratios within each decile, are then computed to illustrate the distribution of

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<sup>7</sup>The sample includes some households with negative incomes, some due to business losses and some to other factors.

<sup>8</sup>In tabulations of expenditure ranking published by the Bureau of Labor Statistics, expenditures are defined to include outlays for cars and only the mortgage interest component of homeowner costs. Some of the rankings in this paper may therefore differ from other published reports based on the same data.

<sup>9</sup>The ranking does not correct for household size using an equivalence scale from applied demand analysis. Future work should explore this issue.

gasoline expenditure patterns. Throughout the analysis, gasoline expenditures are the sum of household outlays for gasoline and motor oil. This study does not attempt to analyze the distribution of indirect gasoline tax expenditures, i.e., the taxes that may be collected from the retail distribution sector but eventually passed on to consumers.

### 1.2 Income- versus Expenditure-Based Incidence

Table 1 presents information on the usual measure of the distribution of gasoline expenditures: the ratio of these expenditures to income for households in different deciles of the pre-tax income distribution.<sup>10</sup> The table shows that low-income households display markedly higher expenditure-to-income ratios than higher-income households. For the entire bottom income decile, this ratio is more than 11%; even for households between the fifth and tenth percentile of the income distribution, gasoline outlays average 6.7% of pretax income. The table shows a relatively smooth decline in the share of income devoted to gasoline, to 4.7% at the sixth decile and only 2.4% in the highest income decile. Evidence like that in Table 1 is frequently invoked to support the regressivity of excise taxes on gasoline.<sup>11</sup> Even ignoring the very bottom of the reported income distribution as noise, the results suggest that low-income households spend between two and three times as much of their income on gasoline as higher-income households.

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<sup>10</sup> Each entry shows the average ratio of gasoline outlays to pretax income for households in the decile.

<sup>11</sup> The recent Congressional Budget Office (1990) study focuses primarily on tax burdens relative to household income. It does present, however, some results using the total expenditure ranking employed in Table 2.

An alternative perspective is provided in Table 2, which shows the fraction of expenditures devoted to gasoline for households grouped by total expenditures. When total expenditures exclude auto purchases and include imputed homeowner rent, consumers in the lowest expenditure decile devote 3.9% of their budgets to gasoline, compared with 5.6% for those in the fifth and sixth deciles. The highest expenditure decile devotes 3.4% of total outlays to gasoline, and if one focuses on the very top of the expenditure distribution, outlays are an even smaller budget share. For households with very high expenditure, those in the top 2.5% of the expenditure distribution, the budget share for gasoline is 3.0%, not significantly lower than the average for households in the highest decile.

The second and third columns of Table 2 consider alternative definitions of household expenditures, but yield similar conclusions on gasoline expenditure patterns. The second column includes outlays for automobiles in the expenditure total; this does not alter the pattern of higher gasoline shares in the middle than at either extreme of the outlay distribution. Because the expenditure total is larger, however, the gasoline share declines in all outlay categories. The average share across all households falls from 5.1% to 4.8%. The last column excludes both imputed homeowner rent and auto purchases from the expenditure. In this case the expenditure shares for the top and bottom expenditure deciles are identical. The average gasoline share in this case rises to 6.2%.

Figure 1 graphs the income and expenditure shares for gasoline, combining the information in Tables 1 and 2. The figure highlights two findings. First, the distributional pattern of gasoline expenditures is distinctly different in the two cases. Households in the middle of the expenditure

distribution devote the largest budget share to gasoline, with levels nearly twice that of households with very high or very low expenditures. Rather than suggesting that gasoline taxes are regressive, the expenditure-based calculations suggest that gasoline excise taxes fall most heavily on middle-class households. Second, the figure shows that the variation in expenditure shares across deciles is much smaller than the variation in gasoline outlays as a share of income. The intergroup inequities associated with the gasoline excise tax are thus much smaller when the calibration is based on expenditure rather than pre-tax income.

The average income and expenditure shares presented above do not address the heterogeneity of households within each decile. Some argue that excise taxes fall unequally on different households with similar tax-paying capacity because of differences in their expenditure patterns. Table 3 presents data on the fraction of households in each expenditure decile with no gasoline expenditures, as well as the share with expenditures which make up more than ten percent of the household budget (roughly twice the average expenditure share). Only 14% of the households in the lowest expenditure decile devote more than ten percent of their budget to gasoline, while more than one third do not report any direct gasoline purchases. The share of households with either type of outlying expenditure pattern declines as one moves up the expenditure distribution. By the sixth decile, for example, fewer than two percent of the households report no gasoline purchases 9.4% report outlays equal to more than ten percent of their budget. None of the households in the top expenditure decile reported either type of extreme outlay pattern.

Households with no gasoline outlays, presumably city-dwellers who use public transportation, are heavily concentrated at the bottom of the

expenditure distribution. Many of these households would actually be made better off by a gasoline tax, since they would not face higher outlays but would receive higher benefits as a result of cost-of-living increases in transfer payments.

The households who would be most heavily burdened by the tax are those who spend more than ten percent of their budget on gasoline. This group is also concentrated in the lower expenditure deciles; in the five lowest deciles, nearly one household in six has a high expenditure share. These high-outlay households typically live in rural areas and are more likely to be in the South than in other regions. Holmes (1976) provides a more detailed analysis of the characteristics of high-gasoline-outlay households, along with an analysis of their burdens following the 1974 oil price shock.<sup>12</sup>

## 2. Why Do Income and Expenditure Rankings Differ?

The dramatic differences between income and expenditure based incidence measures suggests the need to analyze why income and outlay rankings diverge. This section considers two aspects of this question. First, it reports the joint distribution of household income and expenditure ranks, to determine whether differences between the income and expenditure incidence results are due to relatively few households whose income and outlays differ. Second, I present a more detailed analysis of the households whose expenditure ranks exceed their income ranks, since the characteristics of these households could affect the interpretation of the results.

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<sup>12</sup>Hill (1980) examines the same households five years later to investigate various responses — mobility, car purchase, etc. — to higher gasoline prices.

Table 4 reports the joint distribution of income and expenditure decile ranks across households. The upper panel shows how households in a given income decile, corresponding to each row, are allocated to expenditure deciles. The lower panel reports the reverse calculation, indicating how the households in a given expenditure decile are distributed across income deciles. In each case (but for rounding) the row entries should sum to 100.

Several features of the table are noteworthy. First, just over sixty percent of the households in the bottom income decile are also in the bottom expenditure decile.<sup>13</sup> Only fifteen percent of the households in the bottom expenditure decile are ranked above the second income decile. This suggests a substantial group of households who fare poorly on either incidence measure. For this group, gasoline expenditures average 5.0% of income and 3.0% of total expenditures.

Second, the association between income and expenditure rank is similar at the upper and lower ends of the distribution. Seventy-six percent of the households in the bottom expenditure decile have pretax incomes in the first or second income deciles; 77% of the households in the top expenditure deciles have incomes in the top two deciles. These tables suggest that differences between the income and expenditure incidence results, while not due to a very small set of households, are due to approximately one sixth of the sample for whom the income and expenditure rankings differ substantially.

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<sup>13</sup>This should equal the percentage of the households in the lowest expenditure decile who are also in the lowest income decile. In Table 4, however, these numbers are not identical (61% vs. 63%). The disparity arises because the households in the CES sample are weighted by sampling weights. Although each decile is defined to include approximately 10% of the total sampling weight of the CES data set, there can be differences in the effective size of the deciles owing to the nontrivial sampling weight of some households.

The results in Table 4 do not provide any information on the identity of households who are in the bottom income decile, spend heavily on gasoline, yet do not appear in the bottom expenditure decile. Finding that a significant fraction of these households are experiencing transitory low income, or have expenditure in excess of income as part of a lifetime plan, would strengthen the argument for using expenditure rather than income measures of incidence.

Table 5 presents data on the households whose expenditure ranking exceeds their income ranking.<sup>14</sup> The elderly are the single most important group, accounting for nearly one quarter of those whose expenditure rank exceeds their income rank. Another significant group, 7% of those with income ranks below their expenditure ranks, consists of young households. These households may face heavy expenditure needs and rely on loans or transfers from family members to finance this consumption. For both the young and old households, total expenditures may provide a much more reliable measure of long-run economic well-being than current annual income. A similar argument might apply to the households which are isolated in the last column of the table: those with more than two children currently at home. For these households, current expenditures may be high relative to their average lifetime outlays.<sup>15</sup>

Table 5 also presents information on the significance of households who may be experiencing transitory income reductions. Two percent of all

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<sup>14</sup>The table does not describe the relationship between income and expenditure. Most households whose expenditure rank exceeds their income rank spend more than their income, but so do some households with expenditure ranks equal to their income rank.

<sup>15</sup>An alternative approach to analyzing expenditure versus income-based incidence measures would divide each household's outlays by an "equivalent scale" based on its demographic characteristics. This would avoid spurious findings of high expenditure ranks among some large households.

households with expenditure ranks above their income ranks are unemployed; another five percent report illness of some type. For the latter group, medical needs may raise current expenditures at precisely the time when the household's earning capacity is reduced. Nevertheless, these categories account for a relatively small part of the high spending/low income group, suggesting that lifecycle factors are more important than year-to-year income fluctuations in explaining divergences between income and expenditure rankings.

One feature of the Consumer Expenditure Survey data which should be noted is the relatively substantial difference between consumption and income for some non-elderly households, with consumption greater than income. The source of these disparities warrants further exploration, but two possibilities should be considered. One is that both consumption and income are measured with error. This suggests using a weighted average of consumption and income rankings to estimate a household's ability to pay, with weights depending on the relative measurement error variances. A second possibility is that income is systematically under-reported, with many households working part-time in the "underground economy." This explanation implies a strong rationale for focusing on consumption, rather than income, in the incidence analysis.

### 3. Indexed Transfer Income and Gasoline Tax Burdens

The standard analysis of excise tax burdens assumes that a household's income is unaffected by changes in consumer prices'. This assumption is significantly in error, however, for low-income households who receive indexed transfer payments. For these households, tax-induced changes in consumer prices are offset, perhaps with a time lag, by higher payments. This

important institutional feature of current transfer programs affects the incidence of excise taxes, and also implies that the revenue yield from higher taxes is smaller than partial equilibrium calculations would suggest.

Table 6 presents information on the role of indexed transfers at different points in the expenditure distribution. The results are striking. Two thirds of the income received by households in the lowest expenditure decile is indexed. This reflects the importance of elderly families who receive Social Security, as well as other transfer recipients, in this group. Such indexed transfers are also important for households in the second expenditure decile, where they constitute 46% of income, but decline at higher expenditure levels. Only three percent of the income of households in the highest expenditure quintile is indexed for inflation.

Indexation implies that a gasoline tax increase which drives up consumer prices will be partly offset by higher transfer income. The extent of compensation is based on the average expenditure patterns of all households, as reflected in the budget surveys which underlie the Consumer Price Index. For households with large gasoline expenditure, this offset will therefore be incomplete; for other households with little or no spending on gasoline and motor oil, the tax increase will yield an income increase with no offsetting change in the cost of living.

The last two columns of Table 6 provide information on how indexation affects the burden of the gasoline tax. Because the natural metric is the fraction of a household's income which is indexed, the second column in Table 6 reports gasoline expenditures as a share of income for households ranked by total outlays. These data show that even the standard incidence measure, outlays as a percentage of income, does not decline sharply as one moves from

low to high expenditure deciles. In this case, the lowest expenditure decile devotes a lower share of its income to gasoline expenditures than any higher decile.

The last column in Table 6 reports households' "unindexed exposure" to gasoline tax changes. This is defined as (gasoline spending/income) - indexed share of income\* $\beta$ , where  $\beta$  is the average ratio of gasoline expenditure to income in the population. The parameter  $\beta$  measures the extent to which indexed transfer programs will increase in response to higher consumer prices for gasoline. For a household with only indexed income and with a gasoline-to-income ratio equal to the national average, higher gasoline have small distributional effects.<sup>16</sup> For a household with no indexed income, unindexed exposure equals its current spending as a fraction of income.

Table 6 demonstrates that allowing for indexed transfers substantially alters the estimated burden of higher gasoline taxes. For households in the bottom expenditure decile, unindexed exposure averages 0.7% of income. In the second decile, this exposure is 2.8% of income, rising to 4.7% of income for expenditure decile three. Gasoline outlays as a share of income are range between 4.3% and 5.7% of income for the highest seven expenditure deciles. For the households in these deciles, however, the gasoline tax burden is significantly greater than that for low-expenditure households. This casts serious doubt on claims that the gasoline tax burdens "poor" households. While the burden on very well off households is no greater than that on the

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<sup>16</sup>Even in this case, there is a deadweight burden from the tax as the consumer price is higher. The increased income from transfers should be viewed as a lump-sum independent of the household's gasoline purchases.

middle class, the middle class burdens in turn are significantly greater than those at the bottom of the welfare distribution.

Many policies could be combined with a gasoline tax to alter the net distributional burden of a fiscal reform. Expansion of the Earned Income Tax Credit, the Food Stamp Program, or explicit income tax credits for fuel expenditures are all possibilities which are addressed using microsimulation methods in CBO (1990) or KPMG Peat Marwick (1990). None of these "offset policies" reach all of the households affected by higher gasoline taxes, but all could be used to partly blunt the distributional effects.

#### 4. CAFE Standards and the Deadweight Burden of Gasoline Taxes

The foregoing analysis focused on the distributional effects of gasoline taxes with no consideration of their efficiency costs. Assessing the efficiency effects of higher gasoline taxes is complex for two reasons. First, gasoline consumption produces externalities including pollution and highway fatalities. Whether higher gasoline taxes are efficiency-enhancing or efficiency-reducing is consequently an open question.<sup>17</sup> Second, some of the margins along which households might adjust to higher gasoline prices, notably the purchase of more fuel-efficient autos, are subject to other government regulation. Corporate Average Fuel Economy (CAFE) standards specify target fleet fuel economy levels for U.S. and foreign auto producers, along with corporate fines for failure to meet the targets.<sup>18</sup> This section argues that

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<sup>17</sup> Cordes, Nicholson, and Sammartino (1990) and CBO (1990) discuss the external effects of gasoline consumption in some detail.

<sup>18</sup> These regulations are distinct from "gas guzzler" taxes which are levied on particular auto models.

these standards are currently binding, and consequently restrict the degree of consumer response to higher gasoline prices.

Studies of gasoline demand find significant differences between long- and short-run price elasticities. This is because short-run adjustment to higher prices consists mainly of reduced driving, while the long-run adjustment involves changes in the auto fleet and possible relocation of some households. Dahl's (1986) survey concludes that the short-run elasticity of miles driven with respect to gasoline prices is -0.3, while the long-run value is -0.55. A number of studies, however, suggest that the ratio of long- to short-run elasticities is greater. With respect to the miles per gallon of new autos, Dahl reports a short-run elasticity of +0.17, and a long-run value of +0.57. Crandall, et al. (1986) use a quite different methodology, calibrating optimal producer response to changing gasoline prices, and estimate that a one percent increase in real gasoline prices will raise average fuel economy by .72 percent. The net effect of higher gasoline prices on gasoline consumption is the elasticity of miles driven minus the elasticity of miles per gallon with respect to prices. At least half of the long-run adjustment thus takes the form of changing fuel economy demands.

Higher gasoline prices beginning from current levels, however, might not produce any change in fuel economy levels. Table 7 shows the real price of gasoline (in \$1989/gallon) for the last twenty years, along with the fuel economy of new cars sold in the United States. The table shows that in 1989, the fuel economy of new cars sold in the U.S. averaged 28.3 mpg when the CAFE standard was 26.5 mpg.

The table masks important heterogeneity in the relationship between fleet fuel economy and the CAFE standards across manufacturers, however.

Greene (1990) notes that several manufacturers, notably the Japanese, currently exceed the CAFE standards by a substantial margin. The link between fuel prices and auto design characteristics thus seems unaffected by CAFE standards for these producers. Other auto firms, such as BMW and Mercedes, currently violate the CAFE standards and pay significant fines; their behavior in response to higher fuel prices is likely to be mediated by the shape of the CAFE penalty function. Finally, for the three large U.S. auto manufacturers, fleet fuel economy has moved in tandem with the CAFE standards; see Figure 2. This suggests that at least these firms may be constrained by CAFE levels.

The net effect of fuel price changes on long-run gasoline demand depends on the relative market shares of these manufacturers. An accurate analysis of the efficiency cost of higher gasoline excises, however, clearly requires a careful analysis of the interaction between prices and standards.

##### 5. Conclusions

One of the central shortcomings of this paper is its partial equilibrium approach, particularly with respect to two issues. First, higher gasoline taxes would probably result both in higher consumer prices and somewhat lower producer prices for gasoline; some of the burden would therefore be shifted to the owners of current oil reserves. These owners are largely the equity-holders in U.S. oil companies, who are relatively well-off households in the expenditure metric, and foreigners. The ability of the United States to export part of the burden of higher gasoline taxes is an intriguing issue which demands further study. Part of the burden of higher gasoline prices might also fall on owners of relatively low-mile per gallon autos. Kahn (1986) provides clear evidence that used car prices respond to gasoline

prices. Because autos are the second most important asset in many households' portfolios, significant price changes could have important distributional consequences.

The second general-equilibrium issue which deserves analysis concerns the use of gasoline as an intermediate input. This paper has focused only on households' direct consumption of gasoline, neglecting the implicit consumption in many goods which have been transported via gasoline-intensive means. A more complete analysis recognizing indirect consumption could be performed using input-output tables and a computational general equilibrium model.

This paper also raises more general issues about the relative merits of income and consumption for measuring household well-being. The long-standing debate about the relative merits of taxing income and consumption provides a familiar base from which to argue for modifications in standard incidence analyses. However, despite the efforts reported in this paper, the source of differences between consumption- and income-based expenditure analyses remain unclear. Further research is needed to resolve these differences.

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Table 1: Gasoline &amp; Motor Oil Expenditure/Income, by Income Decile, 1986

Income Decile	Gasoline Expenditure/Income
1	11.44%
1 (excluding 0-5%)	6.74
2	6.54
3	6.36
4	6.08
5	4.97
6	4.69
7	4.38
8	3.75
9	3.56
10	2.40

Source: Author's tabulations using 1985 Consumer Expenditure Survey. See text for further details.

Table 2: Gasoline &amp; Motor Oil Expenditure/Total Expenditure, 1986

Expenditure Decile	Expenditure Definition		
	Including Imputed Rent, Excluding Autos	Including Imputed Rent & Autos	Excluding Imputed Rent & Autos
1	3.88	3.70	4.25
2	5.67	5.34	6.52
3	5.83	5.53	6.84
4	6.12	5.67	7.55
5	5.55	5.17	6.62
6	5.64	5.20	7.04
7	5.42	4.94	6.72
8	4.85	4.43	5.99
9	4.82	4.47	6.09
10	3.42	3.20	4.25
Average	5.12	4.76	6.19

Source: Author's tabulations using 1985 Consumer Expenditure Survey. See text for further details.

Table 3: Dispersion of Gasoline &amp; Motor Oil Expenditure Shares

Expenditure Decile	Percent of Consumers with Gasoline Expenditure Share Zero	> 10%
1	36.5%	14.2%
2	11.3	15.6
3	8.4	15.5
4	0.7	16.0
5	4.3	11.1
6	1.9	9.4
7	1.2	6.7
8	0.6	5.1
9	0.6	5.7
10	0	0

Source: Author's tabulation using 1985 Consumer Expenditure Survey.  
 Households are grouped into expenditure deciles based on total expenditures including rental equivalent value of owner-occupied housing, but excluding automobile purchases.

Table 4: Joint Distribution of Expenditure and Income Deciles

Income Decile	Expenditure Decile									
	1	2	3	4	5	6	7	8	9	10
1	61	16	9	4	3	3	1	0	1	3
2	22	34	17	13	7	5	1	1	0	1
3	8	25	19	17	12	7	6	2	2	1
4	4	14	21	14	21	8	8	6	3	1
5	1	10	19	16	18	15	10	7	4	2
6	1	3	10	18	20	17	11	14	4	1
7	1	1	2	8	10	19	24	20	9	7
8	0	0	1	3	7	21	22	20	17	8
9	0	1	1	1	2	5	13	20	32	25
10	0	0	0	1	2	3	8	9	26	51

Expenditure Decile	Income Decile									
	1	2	3	4	5	6	7	8	9	10
1	63	23	8	4	1	1	1	0	0	0
2	15	33	34	14	10	3	1	0	1	0
3	8	17	19	21	20	10	2	1	1	0
4	4	13	18	15	17	19	8	3	1	1
5	2	7	12	21	18	20	9	7	2	2
6	3	5	7	8	15	17	18	21	5	3
7	1	1	6	8	10	10	22	21	13	8
8	0	1	2	6	7	14	19	20	21	10
9	1	0	2	3	4	4	9	16	34	27
10	3	1	1	1	2	1	6	8	26	51

Note: Entries in each panel denote the probability that a person in the income or expenditure decile listed in the row margin would be found in the income or expenditure decile for each column. Calculations are based on 1985 Consumer Expenditure Survey.

Table 5: Who Spends More Than They Make?

Expenditure Decile - Income Decile	> Age 65	< Age 30	Share of Non-Elderly Who Are Unemployed	Sick	> 2 Children
1	25%	9%	1%	4%	18%
2	30	5%	2	6	10
3	35	3%	2	2	18
4 or more	22	5%	0	7	9

Source: Author's tabulations based on 1985 Consumer Expenditure Survey.

Table 6: Income Indexing and Gasoline Tax Burdens

Expenditure Decile	Average Share of Income Indexed	Gasoline Expenditure/ Income	Unindexed Gasoline Spending/Income
1	64.9%	4.18	0.70
2	45.7	5.24	2.79
3	29.4	6.23	4.65
4	20.0	5.78	4.70
5	16.5	5.92	5.03
6	11.6	4.94	4.32
7	6.4	5.51	5.16
8	4.1	4.72	4.50
9	3.1	5.85	5.68
10	3.0	5.17	5.01
Average	18.0	5.38	4.41

Note: Column three is computed by averaging, for all households within a decile, gasoline expenditure/income - indexed income share\*5.38, where 5.38 is the population average ratio of gasoline spending to income as shown in column 2. This implicitly assumes that population average spending patterns are reflected in cost-of-living adjustments to transfer income.

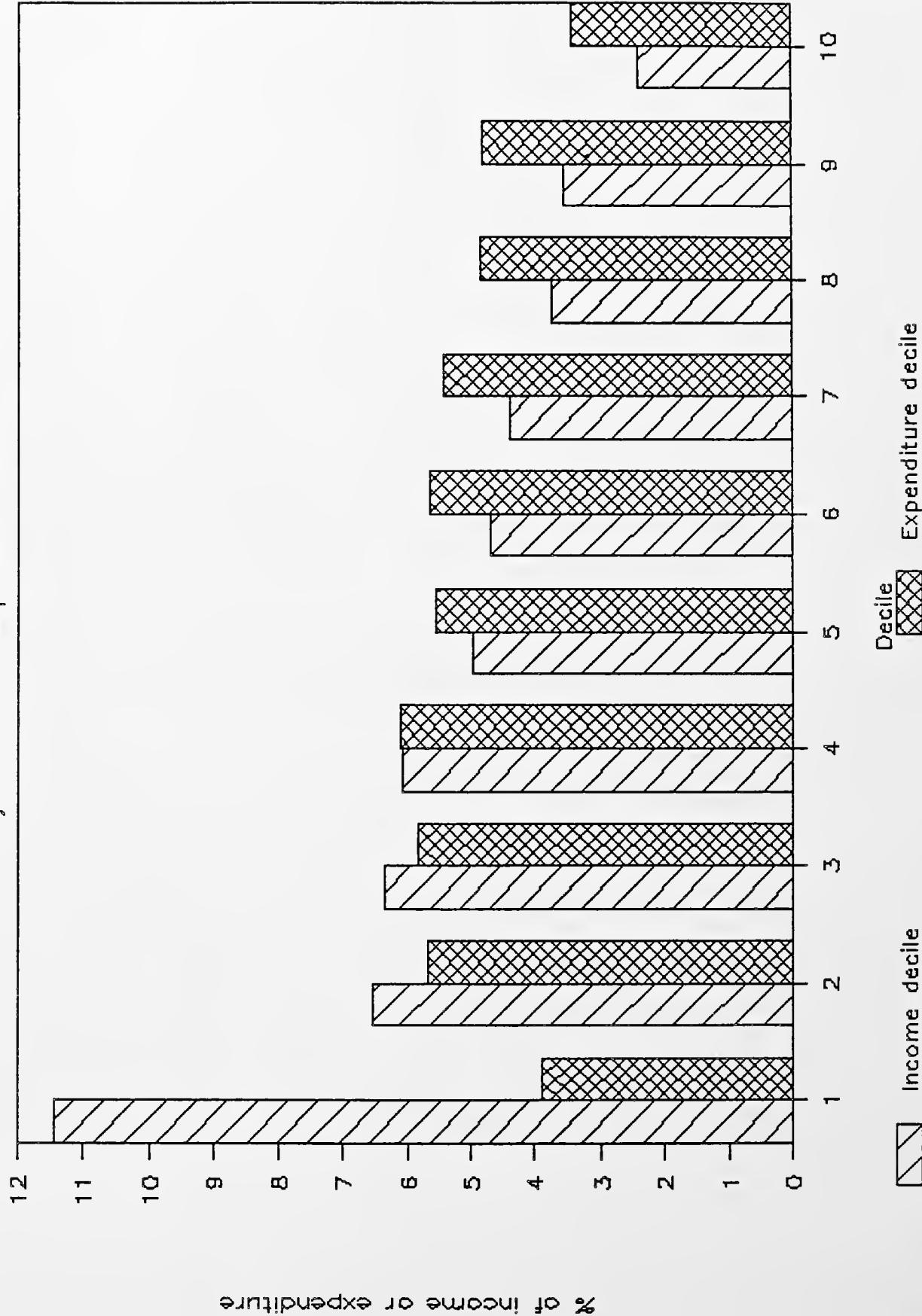
Table 7: Gasoline Prices and Corporate Average Fuel Economy Standards

Year	Gasoline Price/Gallon		Average Fuel Economy	
	Nominal	Real (June 1990\$)	Actual	CAFE Standard
1970	0.36	1.19	14.9	—
1971	0.36	1.15	14.4	—
1972	0.36	1.13	14.5	—
1973	0.40	1.16	14.2	—
1974	0.54	1.41	14.2	—
1975	0.57	1.38	15.8	—
1976	0.60	1.36	17.5	—
1977	0.63	1.35	18.3	—
1978	0.66	1.31	19.9	18.0
1979	0.88	1.58	20.3	19.0
1980	1.22	1.93	24.3	20.0
1981	1.35	1.93	25.9	22.0
1982	1.28	1.73	26.6	24.0
1983	1.23	1.60	26.4	26.0
1984	1.20	1.50	26.9	27.0
1985	1.20	1.45	27.6	27.5
1986	0.93	1.10	28.1	26.0
1987	0.96	1.10	28.4	26.0
1988	0.96	1.06	28.7	26.0
1989	1.06	1.11	28.3	26.5
1990(June)	1.14	1.14	—	—
1990(Sept)	1.35	1.32	—	—

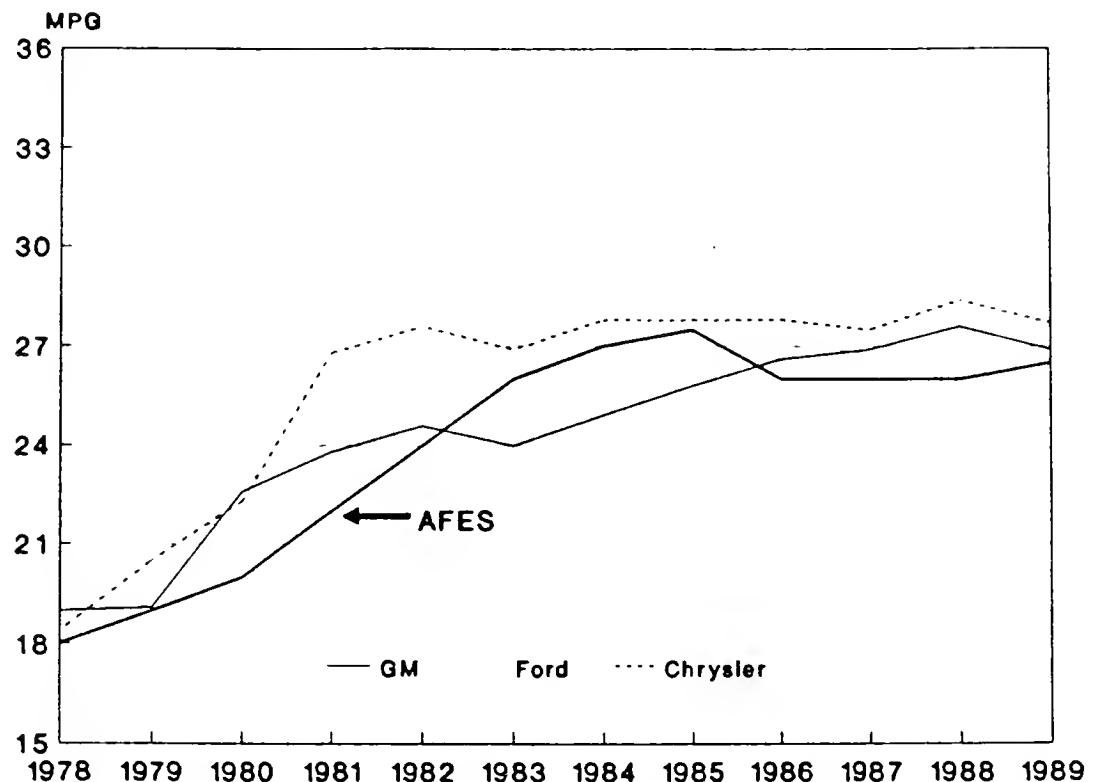
Source: Gasoline price data from Data Resources, Incorporated. Data on fuel economy is drawn from Motor Vehicle Facts and Figures (1989 edition).

Figure 1

Gasoline share of income or expenditure  
by income and expenditure deciles



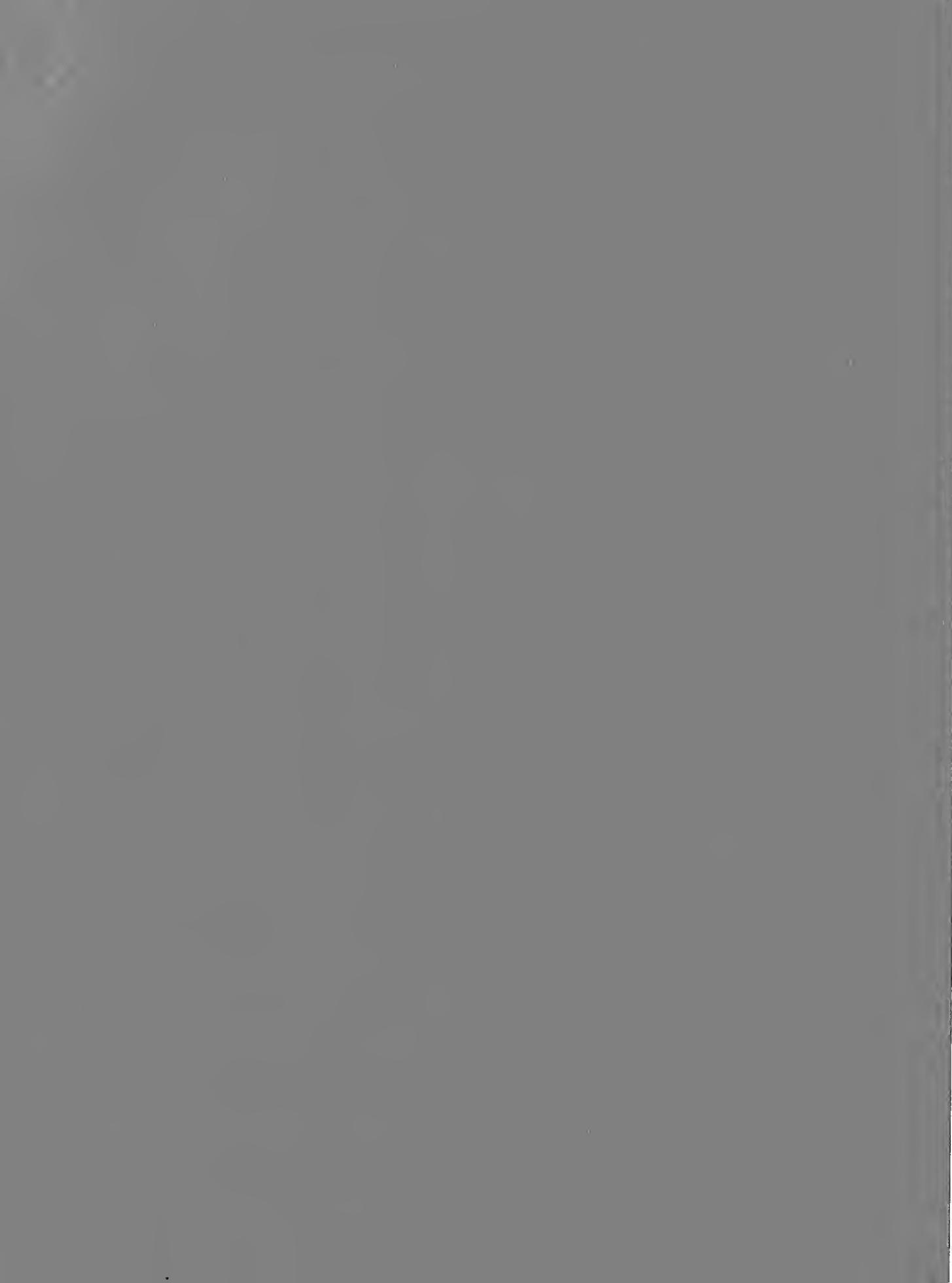
**Figure 2: Corporate Average, MPG vs. Standard – Domestic Vehicles**



Source: David L. Greene, "CAFE or Price?", ENERGY JOURNAL 11 (1990), page 45.



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